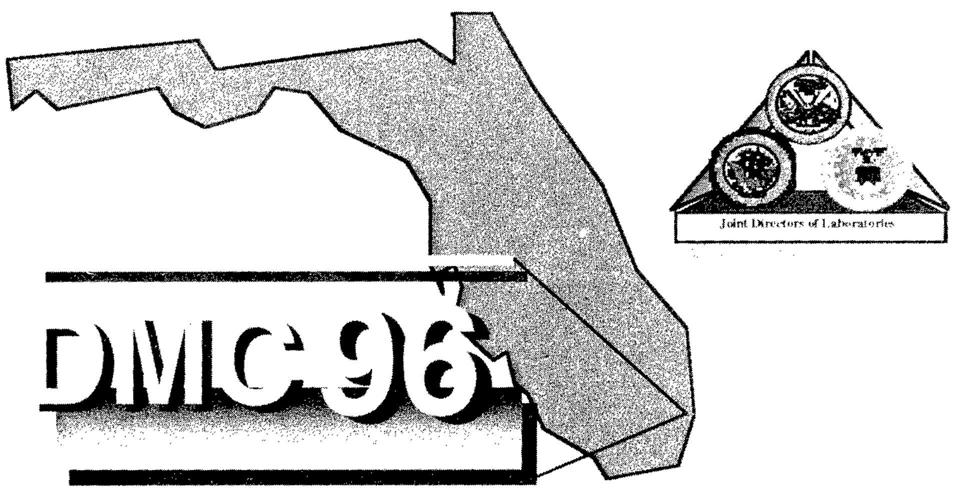
The USAF Manufacturing Technology

PROGRAM STATUS REPORT

Wright Laboratory / Manufacturing Technology Directorate / Wright-Patterson AFB, Ohio
Visit the ManTech Homepage at: http://www.wl.wpafb.af.mil/mtx/mt_home.htm

Winter 1996



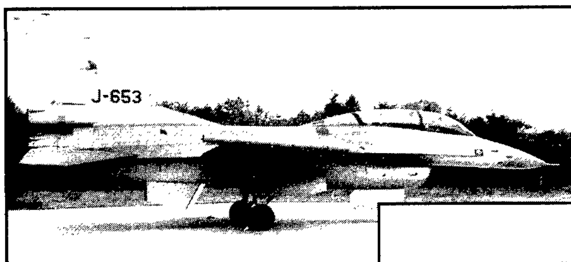
As the manufacturing technology community prepares for the 1996 Defense Manufacturing Conference, the Wright Laboratory Manufacturing Technology Directorate has just published its **1996-97 Project Book Update**, which describes the status of the directorate's projects. For more information on this, see Page 9. The Manufacturing Technology Directorate has also highlighted its top efforts of 1996 for this issue of the Program Status Report.

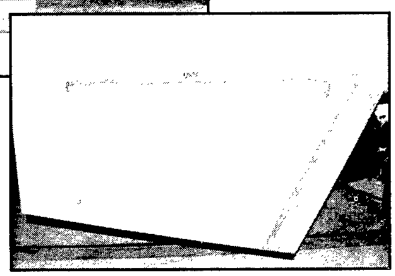
In this issue:

M97-04-2243

Aluminum metal matrix composites increase aging aircraft components' mean time between failure

Insertions of Discontinuously Reinforced Aluminum (DRA) have significantly reduced maintenance and downtime for Air Force aircraft. By using DRA, the F-16 ventral fin mean time between failure (MTBF) has increased from 400 to 6,000 hours with no weight impact and minimal increase in part cost. The F-16 program has reported a 40:1 return on investment due to reduced inspection, maintenance and downtime. Using DRA sheet and improved fasteners, F-16 access door MTBF was increased from 2,000 to 8,000 hours. A 40 percent stress reduction in fatigue prone areas was achieved. Sustainment applications in Navy aircraft and other Air Force aircraft are currently under consideration.





The Defense Production Act (DPA) Title III Program executed by the DPA Branch of the Manufacturing Technology Directorate, allowed DWA Composites to establish a viable DRA production capacity to support DoD and commercial applications. Financial incentives provided under the DPA allowed DWA Composites to establish a high quality material production capacity of 150,000 pounds per year, complete MIL-HDBK-5 testing, and qualify DRA in both DoD and commercial aerospace applications. With DoD and commercial applications in production, DWA is already producing material, and during 1997, is expected to be producing near capacity. The goal of establishing a viable producer of DRA material has been achieved.

The Defense Production Act is a public law which authorizes financial incentives to maintain, establish, or expand domestic production capacity of critical technology items and industrial resources essential to the national defense. The DRA Title III program was initiated in 1989 to establish a viable production capacity of aluminum metal matrix composite material to meet DoD requirements for new systems. During the course of the project, it became apparent that these near term DoD opportunities were in support of aging aircraft sustainment. Penetration in that market required confidence in the material which was provided when the contract was modified to allow for MIL-HDBK-5 data generation and approval. Working with the F-16 office at Ogden Air Logistics Center, the PRAM office, and Lockheed-Martin, the DPA Branch provided resources to qualify DRA for use in F-16 ventral fins and access doors. In addition to the DoD applications, DRA is finding commercial applications. The Pratt and Whitney (P&W) 4084 engine developed to power the Boeing 777 will contain DRA. An already approved application is the fan exit guide vanes for the 112-inch diameter engine. These vanes provide the nacelle structural attachment as well as routing the air flow from the bypass fan. DRA was chosen for this application as a more damage resistant, lower cost replacement for polymer matrix composite vanes. The DRA vanes are not only less expensive to produce, but will also contribute to a lower life cycle cost of the engine for the owner. All of these applications are currently in production.

For more information, circle Reader Response Number 1

Project Engineer:
Philip Tydings
WL/MTPD
(937) 255-3701 Ext 223

Contract Number:
F33733-89-C-1011

Instrument for rapid quantitative and nondestructive wafer microroughness/surface quality evaluation for in-process control

In this Phase I Small Business Innovation Research (SBIR) project, engineers from the Wright Laboratory Manufacturing Technology Directorate worked with Sentec Corporation on a new approach to an optical scanning heterodyne scatterometer. The objective was to establish rapid methods to quantitatively and nondestructively measure the microroughness/surface quality of semiconductor surfaces.

The importance of detecting and identifying sub-micron defects is due to the drive by the semiconductor industry to produce devices with ever-increasing densities. Devices are currently being designed with feature sizes of .35 micron and in the near future, designs will require feature sizes of .18 micron. The latter will require the detection of 2 nm substrate defects to 20 nm sized particles on unpatterned silicon wafers. In addition, the industry is scaling up from 200 mm to 300 mm diameter wafers which will require fewer defects and rapid detection per wafer at all processing stages. To have higher yields, defect data must be processed rapidly in real time to correct processing problems through statistical process control techniques.

The system employed a resolution enhancement technique that provided rapid quantitative submicron surface deposit and surface roughness measurements on semiconductor wafers. The system is capable of resolving vertical heights and lateral widths <100 Å and have a working distance >10 cm in air or vacuum. In addition, the system is able to provide an identification "signature" for different materials deposited on the wafer surface. The scanned image of the wafer provided sharp delineation between surface steps, scratches, and particles whether insulating or metallic. With the rapid response and long working distance, the system can be used for in-process wafer evaluations. Coupled with the system's capability to identify deposits on the wafer surface, the electronically enhanced optical data can lead to analyses through statistical process analysis (SPA) to directly control the processing of silicon wafers in production environments.

In this effort, the feasibility of a new concept to detect and measure sub-micron sized objects on an in-process semiconductor surface was studied. Calculations of the signal-to-noise (S/N) ratio as a function of various physical parameters showed that the proposed system has adequate S/N to detect 10 nm particles on a wafer surface. Compared to conventional scatterometers, the Sentec unit would have a better S/N than conventional devices when particles sizes are smaller than 100 nm. Analysis also showed that the entire surface of a 200 mm wafer could be scanned in five minutes. Computer simulations verified that the signal detected is proportional to the volume density of the contaminants on a wafer. By using several laser lines simultaneously, one can identify the material composition of contaminants on the surface of wafers. The effect of haze could also be reduced. In order to verify the theoretical studies, several breadboard versions of the proposed system were built and tested. Scans across the surface of a standard test wafer showed that the heterodyne method does work.

The optical system's quantitative and nondestructive means to measure microroughness and surface quality of semiconductors during in-process manufacturing can significantly reduce costs and improve the quality and reliability of semiconductor devices used in military and commercial applications. In particular, this capability will be essential in the development of future 256 megabyte DRAMs (Dynamic Random Access Memory) and other high density devices requiring 100 Å resolutions.

Project Engineer:
Walt Spaulding
WL/MTMM
(937) 255-2461

Contract Number:
F33615-95-C-5534

For more information, circle Reader Response Number 2

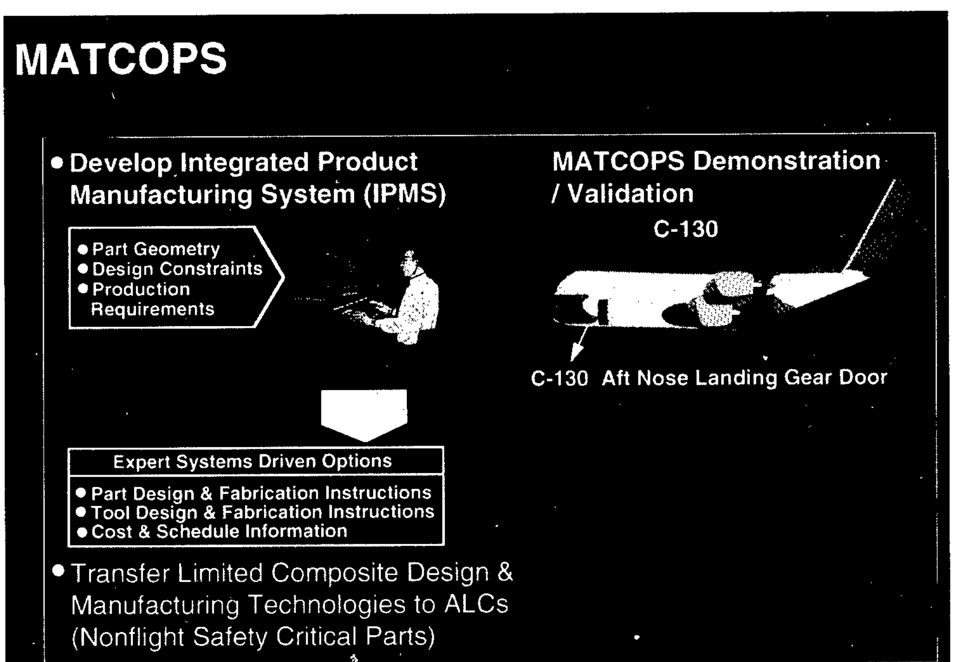
MATCOPS effort produces durable components to replace high maintenance items

The use of advanced composites in new weapon systems has dramatically increased. Advanced composites help achieve the desired goals of increased range, speed, payload, and supportability. The expanded application of composites into more of the airframe's structures introduces important rate production factors such as tool fabrication lead times and life, part reproducibility and integrity, tooling materials, etc., all of which are important considerations to overall manufacturing costs. In many cases, the component design, tool design and manufacturing process are far more costly than producing the parts themselves.

Personnel from the Wright Laboratory Manufacturing Technology Directorate have taken on the challenge of transitioning an enhanced composite design capability for the redesign of existing aircraft components to the Air Logistic Centers (ALCs). The goal of the Manufacturing of Thermoplastic Composite Preferred Spares (MATCOPS) effort is to enhance (ALC) composites design capability through the development of an integrated design/manufacturing knowledge-based expert system, called the Integrated Product Manufacturing System (IPMS). Validation of the system will be accomplished by establishing a repair and limited remanufacturing capability at participating Air Logistic Centers (ALCs).

This effort will establish and validate an integrated methodology for the design and manufacture of advanced composite structural components. Emphasis will be placed on the use of current design/manufacturing technologies, information management and process modeling to establish and validate an expert system capable of assimilating component modeling, materials, and analysis information into a knowledge-based advisor system. The expert system will be used for the re-design of existing secondary, non-flight-safety-critical metal aircraft structure to composites. The IPMS guides the user through design, analysis and process selection activities. It automates some drafting and analysis functions. A CAD system will be integrated with the other IPMS components to allow for the generation of a 3-D CAD model, process specifications, manufacturing instructions, a set of part features, tool designs and fabrication instructions, and high level cost and schedule information.

The program will be accomplished in three phases. Phase I will develop the system architecture and supporting domain knowledge. Two parts from existing Air Force parts that have exhibited service life problems will be selected for use in Phase III. During Phase II, the IPMS will be built, and the system logic will be validated and demonstrated. This validation will occur by using the IPMS to generate examples of part design and material/fabrication guidelines for airframe components which have previously been designed and manufactured on other programs. Phase III will involve the implementation of the IPMS at the designated ALCs. The parts identified in Phase I will be redesigned, and the necessary tool designs,



For more information, circle Reader Response Number 3

materials and process specifications, tool and part manufacturing instructions will be generated. Tooling and manufacturing prototype parts will be built, and then a limited production run at the ALC will occur.

The MATCOPS effort will allow the Air Logistic Centers to efficiently replace high maintenance items with composite components which are more durable and would decrease overall operations costs.

The IPMS system is currently planned for implementation at Northrop (the prime contractor), two ALC's and one Beta Site. The IPMS could be transitioned to industry and other ALC's for both military and commercial uses.

Project Engineer:
Diana Carlin
WL/MTPN
(937) 255-7277

Contract Number:
F33615-91-C-5717

Automated repair capability developed for printed wiring assemblies

Engineers from the Wright Laboratory Manufacturing Technology Directorate, in conjunction with Westinghouse Electric Corporation, have established an automated modular system for the repair of printed wiring assemblies (PWAs). The system identifies and removes conformal coatings, removes identified failed PWA components, replaces and solders the component, and provides an operator assisted means for visual inspection.

The repair of PWAs, and more specifically the need to identify and remove conformal coatings followed by the replacement of defective components on PWAs, has traditionally been performed using manual techniques. As the complexity of the PWAs continues to increase, the skill required to replace defective components has increased to the point where manual replacement is obsolete. While commercial PWA rework equipment is available, these stations are semi-automatic and still require a high degree of manual intervention. These commercial rework stations have a role to play, but they will not solve the substantive problem associated with the ever-increasing PWA complexity, because they rely on variable machine operator skills. This variability seriously impacts the consistency of process quality. Traditional methods have also relied on hazardous chemicals to remove conformal coatings. A fully automated system was needed that could provide consistent, reliable, high-quality repairs while providing an environmentally safe workstation.

This program designed a system which consists of three in-line work stations, with a conveyor for automatic transfer between stations. First, the contractor performed a needs analysis and developed a conceptual, then detailed, design for the system. This system took advantage of existing technology, thereby minimizing risk. An approved design was then validated at the contractor's facility.

The approach included: Fourier Transform Infrared Spectroscopy to identify the various types of conformal coatings; abrasive blasting with an anti-static plastic media for conformal coating removal; and focused infrared heating for desoldering of components. Master control of the repair process resides on the supervisory system. This system has a multi-tasking computer that supervises and monitors the overall repair process.

Three modules were fabricated, and performance validation of these modules is being conducted. This program established an automated repair capability for advanced PWA boards, which would otherwise be unrepairable.

For more information, circle Reader Response Number 4

Project Engineer:
Troy Strouth
WL/MTMM
(937) 255-2461

Contract Number:
F33615-91-C-5700

Effort attacks high costs of gas turbine engines

In the past, performance at any cost was the rule in production of U.S. military products. But with reduced defense spending, engine designers, material developers and manufacturing engineers must confront a new challenge. The future of the gas turbine engine industry will be based not only on performance, but on affordability as well.

A need exists to establish a national initiative to address the affordability of gas turbine engines, by attacking known existing high cost areas. Under a program sponsored by the Wright Laboratory Manufacturing Technology Directorate, Howmet Corporation teamed with PCC, Pratt & Whitney, General Electric Aircraft Engines and Lockheed-Martin to address this issue by effectively coupling advanced technology tools, new business practices and policies, and lean principles.

Leading this effort is the investment casting supplier base community, with engine manufacturers as team members defining the requirements. The focus is on investment casting of complex nickel-base superalloy and titanium-base airfoil and large structural castings for man-rated gas turbine engines. The program is addressing production requirements, while placing emphasis on reducing lead times for prototype and production castings, significant reduction in rework of structural castings, reduction in scrappage rates of airfoils, and elimination of inefficient business practices.

The program's goal is to achieve a 50 percent improvement in quality as related to structural rework, and airfoil tolerance and single crystal scrap, 25-50 percent improvement in cycle time as related to production cycle time, tooling procurement time, and new part design and process development time. This project will enable the U.S. to maintain its technological superiority in the gas turbine engine business while providing for affordable propulsion for future systems.

For more information, circle Reader Response Number 5

Project Engineer:
Siamack Mazdiyasni
WL/MTPM
(937) 255-2413

Cooperative Agreement Number:
F33615-95-2-5555

Manufacturing Technology Directorate publishes 1996-97 Project Book Update

The latest issue of the book which describes the status of Wright Laboratory Manufacturing Technology Directorate projects is now in print. The **1996-97 Manufacturing Technology Directorate Project Book Update** was recently published and should be on its way to people who are on the mailing list for the Program Status Report. It will also be available soon on the Manufacturing Technology Directorate homepage at: **http://www.wl.wpafb.af.mil/mtx/mt_home.htm**

Anyone not on the mailing list or who cannot access this homepage should contact the directorate's Technology Transfer Center, at (937) 256-0194, to obtain a copy.

Manufacturing Technology USAF

Joint effort produces flight-capable prototype thermoplastic composite radome

People from the Wright Laboratory Manufacturing Technology Directorate (WL/MT), working with E-Systems Incorporated, are developing a flight-capable prototype radome constructed of thermoplastic composite materials resistant to the chronic problems found in thermoset composite radomes. Design data, processing procedures, manufacturing techniques, and quality assurance requirements are being generated that are necessary for reliable and consistent fabrication of thermoplastic composite materials into solid and multilayer sandwich radomes. The data and processes being validated and documented in this effort are applicable to a broad range of radome structures and systems.

Current technology for radomes and antennas use composite materials consisting of thermoset resin systems reinforced with either glass, quartz or aramid fibers. The use of thermoset composites has resulted in certain chronic fabrication and long-term durability and environmental problems which increased cost and decreased reliability and maintainability. These chronic problems with thermoset composite methods have manifested themselves in four main areas: 1) unacceptable moisture absorption which decreased performance; 2) inadequate toughness and impact resistance; 3) severe rain erosion unless protected by a coating; and 4) high fabrication and repair expenses.

This task will: 1) build off current materials characteristics definition projects; 2) produce multiple radome applications for demonstration (solid/honeycomb); 3) optimize rapid manufacturing techniques and processes; 4) demonstrate and verify results; and 5) develop a systems application.

This program will group radomes into families, improve radome system supportability, reduce electronic system performance degradation, optimize rapid manufacturing techniques/processes, and reduce acquisition costs. The effort will also establish methods to transfer the validated technology to other systems.

For more information, circle Reader Response Number 6

Project Engineer:
Michael Waddell
WL/MTPN
(937) 255-7277

Contract Number:
F33600-90-G-5308

Integrated Product Processing Initiative closes gap between design and manufacturing

Bridging the gap between design and manufacture is a critical driver for achieving weapon system affordability. Under the direction of the Wright Laboratory Manufacturing Technology Directorate, Raytheon Electronic Systems is leading a team to directly attack this problem through the Integrated Product Processing Initiative (IPPI) Program. IPPI focuses on two key elements. First, a large technology void existed in the transfer of neutral product information between design and manufacturing. Manufacturing functions, such as process planning and shop floor machine programming, need direct and efficient access to detailed product design information. Second, this information needs to support much of the manual operations of today's manufacturing environment and the more advanced automated manufacturing shops that are emerging for the future. The IPPI process planning tools support these key elements and ease the transition of key manufacturing information to machine shop operators through the use of the strongest Intranet tools available today. Autonomously generated intermediate part representations, machine tool code, specifications/standards, rotating 3-D models of the part, and other information are all being linked for presentation via commercial browsers to computers on the shop floor.

The IPPI Program approaches manufacturing process planning by incorporating the historical expertise from a broad range of planners and parts to address: process selection options, resource (machines and personnel) availability, raw stock selection, and operation details. This detailed information is linked to manufacturing floor systems, such as a finite capacity scheduler and a manufacturing activity modeler to link individual jobs to each other and the manufacturing floor as a whole. By controlling and optimizing these interrelationships, IPPI reduces cycle time, individual job errors, and total manufacturing costs.

For more information, circle Reader Response Number 7

The cornerstone of the approach entails implementing a complete, neutral product and process information thread based on STEP (Standard for the Exchange of Product Model Data). In STEP terminology, IPPI has advanced the viability of AP203 for 3-D geometric part representation and configuration control, AP213 for manufacturing process planning, and AP224 for manufacturing based geometric features.

Several IPPI tools and techniques have been incorporated into commercial products that were used in the development of the system. Also, IPPI has been demonstrated and initially implemented in the Raytheon Andover Manufacturing Plant.

IPPI tools, techniques and products have been leveraged into at least two Defense Advanced Research Projects Agency (DARPA) funded projects. The Integrated Process Planning/Production Scheduling (IP^{3}S) Project integrated the IPPI process planning capabilities into a higher level manufacturing control system. IP^{3}S is a DARPA Agile Manufacturing Initiative. The Manufacturing Simulation Driver Project is building simulation tools over the IP^{3}S control structure to allow predictive simulation of manufacturing operations, design trade-offs based on current manufacturing constraints, and provide input and validation of the corporate manufacturing strategy.

Project Engineer:
John Barnes
WL/MTIM
(937) 255-7371

Contract Number:
F33615-93-C-5319

Lean Implementation Initiative lessens risks of implementing recommendations from LAI

Under a program sponsored by the Wright Laboratory Manufacturing Technology Directorate, Lockheed-Martin recently began work on a project which will apply the leading edge production philosophy of modular flow, as identified by the Lean Aircraft Initiative (LAI), to the production of F-22 aircraft.

The Lean Implementation Initiative (LII) is a joint services effort to mitigate the risk of implementing recommendations from the LAI. The main objective of the Lockheed effort is to optimize the enterprise flow in several areas in order to reduce the cycle time from order to delivery for the F-22 from 32 months to 24 months.

The Factory Operations Focus Group of the LAI has embraced factory flow optimization as an enabling practice. One method to achieve flow optimization is rearrangement of the factory to group similar products along their common production processes, while striving for continuous flow through and across those groupings or modules. The effort targets those cycle time improvements within a manufacturing facility that enhance the productivity and quality of production activities and create an environment for continuous improvement, commensurate with reductions in cost. An approach for achieving these improvements is through a Modular Factory concept.

The Modular Factory is a reorganization of production resources into semi-autonomous modules, each with total responsibility and authority for a set of processes, adding value to the product to ensure success for the entire enterprise. Typically, modules are arranged within the factory around the assembly sequence, with the next higher assembly operation as the customer. The module is characterized by: empowerment of workers and teams, emphasis on training for skill interchangeability, dedicated capital equipment, aggressive inventory reduction, focus on work flow velocity, shop floor density to reduce transportation time, and gain-sharing incentives for employees. Many enabling approaches are employed in reaching these objectives, including benchmarking, pull-driven scheduling, activity-based methods, process variability reduction, simulation, and labor-management cooperation. Derivation and demonstration of these concepts for the defense production environment will require consideration of business practice changes, infrastructure improvements, and identification of the barriers and disincentives to their accomplishment.

The Lockheed program will apply flow optimization and modular factory principles to administrative processes, long lead-time suppliers, and production processes to reach the cycle time objective. A reduced average unit production price is another expected benefit.

Project Engineer:
Brench Boden
WL/MTII
(937) 255-5674

Cooperative Agreement Number:
F33615-96-2-5620

For more information, circle Reader Response Number 8

Lean Aircraft Initiative considers adoption and implementation of lean principles and practices

Lean concepts present the U.S. military aircraft industry with an opportunity to address the challenges presented by both reductions in DoD procurement and world-wide competition. The adoption of lean principles and practices will allow the industry to meet customer requirements for affordability and responsiveness without sacrificing performance. Through the Lean Aircraft Initiative (LAI), the industry's position as the world's leading producer of advanced technology aircraft systems will be strengthened.

The objective of the LAI is to develop a framework for implementation of enterprise-wide lean principles and practices that will better support defense aircraft needs over the next 30 years.

LAI had its genesis in the International Motor Vehicle Program (IMVP) conducted by a Massachusetts Institute of Technology (MIT) research team as described in the book, "The Machine that Changed the World." "Lean" is a fundamentally different approach to managing and organizing the enterprise. LAI is accelerating and focusing the pace of change toward lean in the aircraft industry by providing industry leadership with a common understanding of principles, priorities and data. LAI provides a collaborative environment to define areas of enabling research and development, benchmark and share experiences and knowledge. During past business draw-downs the tendency has been to simply shrink in place while awaiting the next surge in defense spending. LAI member companies are not simply becoming smaller — they are also becoming leaner. Many member companies were well on their way to adopting lean practices before the advent of LAI. Top leadership was driving these companies toward sharply lower costs, shorter cycle times, and improved quality by:

- Re-engineering organizations and key processes including all aspects of the product realization process starting with Integrated Product/Process Development (IP/PD).
- Focusing on step-function improvements in quality, waste minimization and response time.
- Building strong supplier relationships through vertical partnering/teaming.
- Using less of everything: less design time, less inventory, fewer buffers, fewer management layers, less capital, less cycle time, and fewer suppliers.

For more information, circle Reader Response Number 9

The phrase, "Lean Production" refers to all aspects of product realization in the enterprise, and was coined by MIT based on this benchmark study. The IMVP was able to use a single manufacturer, Toyota, as a benchmark for lean implementation within the auto industry. With the IMVP research acting as a catalyst, the US auto industry responded by re-engineering management, design and manufacturing processes to become competitive in the global market.

During Phase I of the LAI (September 1993-September 1996), development of a composite lean enterprise model, drawn from research across the industry and the applicable findings of the IMVP, was initiated. This model will provide the framework and catalyst for change within the military aircraft community (industry and government) in a manner similar to what the published IMVP results did for domestic automakers. The LAI is unique from the IMVP in that the customer, DoD, is an equal partner with industry, labor and MIT in initiating fundamental change throughout the military aircraft "value stream."

Aeronautical System Center's Wright Laboratory Manufacturing Technology Directorate initiated a "quick look" assessment with MIT and industry on the applicability of "lean production" to the military aircraft industry. The assessment concluded lean principles do apply and stated significant benefits were possible if lean practices were adopted. Senior leadership in industry, organized labor and government endorsed the initiative and have been aggressively pursuing this research. LAI is in its third and final year of Phase I research. Current efforts are focused on key customer expectations.

The current LAI organization is a model collaborative effort between the Air Force and its partners within other government agencies, industry, labor and academia. An Executive Board comprised of senior industry, organized labor, government personnel and academia is steering the effort. LAI has broken ground in establishing a partnership with the Air Force aircraft process owner, ASC, through management involvement at the Executive Board level to participation by ASC functional experts on the research teams. Research is on-going in five focus areas: product development, factory operations, policy and external en-

vironment, organization and human resources, and supplier systems and relationships.

To date, MIT has authored over twenty publications as a result of LAI surveys, case studies and site visits. These publications serve as a basis for populating the Lean Enterprise Model (LEM) which will act as the primary means of transitioning the results of LAI research into real application. The LEM provides a framework for identifying and evaluating lean practices and metrics in such a way that consortia members can understand the relative lean status of his or her own organization and factors which can be addressed to yield desired changes. Development of the LEM during Phase I focused on definition of a hierarchical information structure and selection of automated media for dissemination of the results. The success of Phase I of the LAI led to the initiation of Phase II (September 1996-September 1999) with a broadly expanded paying membership.

Lean forums were conducted to transition research findings to the customer base and establish requirements for both technology and acquisition planning processes. Examples of these findings include improved program performance tied to integrated cost and design data bases, use of "best" commercial practices such as a "Software Factory Process" and research indicating successful integrated product team practices vary based on product technical risk and complexity. Air Force ManTech is currently sponsoring a series of pilot projects that implement lean practices and is investigating similar efforts within the Air Force sustainment community.

Industry members are taking LAI findings and applying lean practices within their companies, as evidenced during government/industry information exchanges.

During Phase I, member companies were visited by a Joint Air Force and MIT team to assess progress and approaches in implementing lean practices. The team saw first hand the results of the marked changes in the aerospace defense industrial base. Each member company was expending tremendous energy on the journey to becoming lean and agreed the benchmarking and interactions resulting from LAI were powerful change agents providing needed direction. They all recognize that no one company has all of the best lean practices.

Progress toward "lean" in the military aircraft industry had begun prior to the LAI, but largely in isolated pockets. LAI, however, has fostered its implementation. Dramatically reduced product cycle times, significant cost reductions and improved quality are progressively being achieved, and the LAI is serving as a unique platform for linking all the stakeholders, both by providing a forum for interchange and by developing a growing database of practices and supporting information. Implementation, the end goal for the project, will be the basis for validating LAI's impact.

Visit the LAI Website at: http://web.mit.edu/ctpid/www/lai/

For additional info, contact (at MIT) Catherine Avril (617) 253-6794, or (at USAF WL/MTAS) Nitin C. Shah (937) 255-3701, ext.249.

Project Engineer:
Nitin Shah
WL/MTAS
(937) 255-3701 Ext 249

Cooperative Agreement Number:
F33615-93-2-4316

Welded titanium aircraft structures

Tactical fighter aircraft require titanium structures to meet strength and temperature requirements. This class of structure represents up to 30 percent of an aircraft's structural weight. Conventional titanium aircraft structure is difficult and expensive to fabricate because of the extensive machining, hot forming, drilling, and fastening involved. The construction of titanium structural assemblies by welding can potentially be lighter and more economical with less material waste.

Boeing Company, under contract to Wright Laboratory Manufacturing Technology Directorate, and in conjunction with Air Force personnel, have developed improvements in the affordability for design and manufacturing producibility required to produce large, complex, high-quality welded titanium fighter airframe assemblies, improving structural reliability and weight performance.

The objective of the Manufacturing Technology for Welded Titanium Aircraft Structures program was to develop, demonstrate, and validate new welding processes and associated manufacturing methods that significantly reduce the cost and risks associated with implementing and using these processes in the production of fighter aircraft, while still meeting performance, quality, supportability, reliability, and flexibility requirements. Achievement of these objectives supports the overall program goal of 30 percent cost reduction and up to 10 percent weight reduction for welded titanium structures. We identified an aft fuselage component as the baseline design on which to focus process improvements. The component is composed of machined titanium (Ti-6Al-4V) components that are assembled into structure with electron beam welds. It is a large and complex welded assembly and as such, was an excellent candidate for process improvement, cost reduction, weight reduction, and production implementation. Cost and weight data for the component were gathered to identify those designs and steps in the welding process which contributed most to weight and cost. Using an Integrated Product Team (IPT) approach, cost and weight drivers were identified and the selection process focused on those drivers and identified technologies which had the highest implementation potential to reduce the cost and weight. The program consisted of three phases: Phase I, Requirements and Technology Assessment; Phase II, Process Development; and Phase III, Manufacturing Demonstration. Phase I: (1) defined a "baseline" for cost, weight, and risk comparison purposes; (2) developed alternative designs and processes; (3) identified cost and risk drivers; (4) conducted a state-of-the-art (SOTA) assessment; and (5) selected processes which offer the highest potential payoffs. Phase II developed preliminary designs, fabrication plans, manufacturing processes, and tooling concepts and validated them by building and testing subscale components. Phase III, consisted of producing a full-scale demonstration component using the selected, high-payoff improvements in designs, processes, and tooling to verify the concepts. Demonstration of the improvements on full size hardware was performed to facilitate implementation of the processes to production.

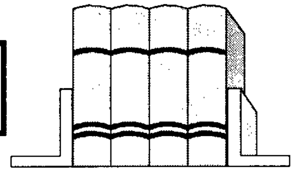
The program developed, demonstrated, and implemented producibility improvements in the manufacturing processes required to affordably produce large, complex, high quality welded titanium fighter airframe assemblies. The developed processes also improve structural reliability and reduce weight in the assembled structure. The cost drivers associated with the fabrication of the welded titanium structure of aft fuselage components were identified to be the ancillary processes associated with the welding process and not the electron beam welding process itself. Process improvements including: localized weld repair, localized stress relief, localized cleaning methods, laser weld finishing passes, automated inspection methods, witness line application tools, robotic weld bead shaving and revised electron beam welding schedules were developed to address each of the identified cost drivers. Each of the process improvements were demonstrated and validated on the demonstration component to illustrate the production readiness and to facilitate the rapid implementation of the processes to the production floor. The localized weld repair, localized cleaning methods and witness line application tools have been incorporated into the processes being used to build fighter aircraft components. Other process improvements will be implemented later during production. It is estimated that implementation of all of the process improvements into the production of a fighter aircraft aft fuselage structure would result in a cost avoidance exceeding 100 million dollars, over the life of the program.

For more information, circle Reader Response Number 10

Project Engineer:
Kevin Spitzer
WL/MTPM
(937) 255-2413

Contract Number:
F33615-93-C-4302

Reports



Manufacturing Technology for Multifunctional Radomes

Alog Number: 3857
Contract Number: F33615-93-C-4312
Technical Report Number: WL-TR-96-8006
Distribution: LIMITED

Manufacturing of Thermoplastic Composite Preferred Spares (MATCOPS)

Alog Number: 3858
Contract Number: F33615-91-C-5717
Technical Report Number: INTERIM
Distribution: LIMITED

Manufacturing Integration/Infrastructure Technologies

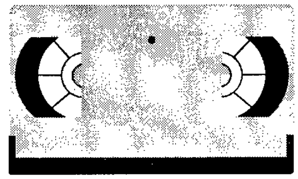
Alog Number: 3854
Contract Number: F33615-95-C-5557
Technical Report Number: INTERIM
Distribution: LIMITED

Imaging Pyrometry Semi-Conductor Process Control

Alog Number: 3853
Contract Number: F33615-92-C-5817
Technical Report Number: WL-TR-95-8010
Distribution: LIMITED

Titanium Matrix Composite Exhaust Nozzle Components

Alog Numbers: 3850
Contract Number: F33615-91-C-5730
Technical Report Number: WL-TR-95-8017
Distribution: LIMITED



Videos

Optical Measuring System No. P-736

Alog Number: 72
Length: 6:45
Distribution: LIMITED

Sandwich Flir Windows Time Code Burn-In

Alog Number: 73
Length: 00:55
Distribution: LIMITED

Manufacturing Technology for Integration of Advanced Repair Bonding Techniques No. P-804

Alog Number: 74
Length: 14:42
Distribution: LIMITED

Ordering

Wright-Patterson personnel or their contractors may contact the Wright Laboratory (WL) Technical Library, (937) 255-7415. They must be registered with the library in order to obtain reports. Classified or limited documents will be released only to the contract monitor.

Non-Wright-Patterson personnel who wish to obtain any WL documents, and are registered with the Defense Technical Information Center, should contact the center. To register call 1-800-CAL-DTIC.

To obtain unlimited/unclassified documents, contact the National Technical Information Service, (703) 487-4650.

For further information, or to order videos, call the Technology Transfer Center at (937) 256-0194.

End of Contract Forecast

DATE	PROJECT TITLE CONTRACT NO.	PRIME CONTRACTOR	POINT OF CONTACT
December 1996	Fluxless, No Clean, Solder Processing of Components Printed Wiring Board F33615-95-2-5511	MCNC, Electronic Technologies Division Research Triangle Park, NC	Ron Bing (937) 255-2461
December 1996	Design and Manufacture of Low Cost Composites (DMLCC), Fuselage F33615-91-C-5716	Boeing Company, Military Airplane Division Seattle, WA	Daniel Brewer (937) 255-7278
December 1996	Design and Manufacture of Low Cost Composites (DMLCC), Wing F33615-91-C-5720	McDonnell Douglas Corporation, Aircraft Division, St Louis, MO	Kenneth Ronald (937) 255-7278
December 1996	Jet Vapor Deposition: A New Environmentally Sound Manufacturing Process F33615-95-C-5510	Jet Process Corporation New Haven, CT	Walt Spaulding (937) 255-2461
December 1996	Cell for Integrated Manufacturing Protocols, Architectures and Logistics (CIMPAL) F33615-90-C-5003	Central State University Wilberforce, OH	David See (937) 255-3612
December 1996	PDES Application Protocols For Electronics (PAP-E) F33615-91-C-5718	Intermetrics Incorporated McLean, VA	Bill Russell (937) 255-7371
December 1996	Thoroughly Testing Known Good Die F33615-94-C-4401	Tektronix Incorporated Wilsonville, OR	Bill Russell (937) 255-7371
January 1997	High Temperature Bagging/Sealant Materials for Composite Manufacturing F33615-96-C-5626	Utility Development Corporation Livingston, NJ	Vincent Johnson (937) 255-7277
January 1997	Smart Electron Cyclotron Resonance (ECR) Plasma Etching F33615-92-C-5972	University of Michigan Ann Arbor, MI	Capt. Scott Montgomery (937) 255-2461
January 1997	Large Scale System Simulation & Resource Scheduling Based on Autonomous Agents F33615-95-C-5524	Intelligent Automation Incorporated Rockville, MD	James Poindexter (937) 255-8589
January 1997	Labor Infrastructure for Agile High Performance (AHP) Transformations F33615-95-C-5512	Work & Technology Institute Washington, DC	Capt. Paul Bentley (937) 255-7371
January 1997	Alternatives to the Use of Fluoride and Hydrogen Fluoride in Electronics F33615-95-C-5501	Georgia Institute of Technology, School of Electrical & Computer Engineering Atlanta, GA	Ron Bing (937) 255-2461
January 1997	Revolutionary Environmental Manufacture of Printed Wiring Boards with Electroless Plating and Conductive Inks F33615-95-C-5505	Microelectronics & Computer Technology Austin, TX	Ron Bing (937) 255-2461
January 1997	Permanent Dry Film Resist for Printed Wiring Board Process Simplification and Environmental Benefit F33615-95-C-5504	DuPont Lanxide Company Incorporated Research Triangle Park, NC	Ron Bing (937) 255-2461

☆U.S. GOVERNMENT PRINTING OFFICE: 1996 - 549-003/60202

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS MAIL PERMIT NO. 1006 DAYTON, OH

POSTAGE WILL BE PAID BY ADDRESSEE

ManTech Technology Transfer Center
WL/MTX Building 653
2977 P Street, Suite 6
WPAFB OH 45433-9905

(To mail, remove this page. Fold in half on dotted line, this side facing out. Seal open end with piece of tape at top — DO NOT STAPLE! No postage necessary.)

READER REPLY MAIL

- ❑ I am on the Program Status Report mailing list. Please update my address.
- ❑ Add me to the Manufacturing Technology Program Status Report mailing list.
- ❑ Remove me from the Manufacturing Technology Program Status Report mailing list.

Circle the numbers of technology items about which you would like more information:

1 2 3 4 5 6 7 8 9 10

Comments:____

____

____

Please attach current business card or fill in the blanks below.

Name____________________________

Company____________________________

Address____________________________

City____________________________

State__________ **Zip**__________

Email Address____________________________

The USAF Manufacturing Technology

PROGRAM STATUS REPORT

Winter 1996

APPROVED FOR PUBLIC RELEASE

The Manufacturing Technology (MT) Program Status Report is designed to inform you of significant accomplishments, forthcoming events of widespread interest, and to expedite direct exchanges between government and industry management concerned with broadbased MT activities. Recipients are encouraged to route the Status Report to associates and other organizational functions engaged in MT program activities. All comments relating to this Status Report should be directed to WL/MTX (Program Status Report), Building 653, 2977 P Street, Suite 6, Wright-Patterson AFB OH 45433-7739. Telephone: (937) 256-0194. Approved for public release (ASC/PA#96-2737)

FOREIGN DISSEMINATION

Details regarding many specific MT programs are subject to special export controls. Therefore, follow-up from any foreign sources should be processed through embassy channels following normal procedures for request of technical information or technology transfer.

Winter 1996

ManTech Technology Transfer Center
WL/MTX Building 653
2977 P Street, Suite 6
WPAFB OH 45433-7739

Official Business